Wheat breeding for Southern Brazil: focusing on Fusarium head blight resistance

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Biotrigo Team

U.S. Wheat & Barley
Scab Initiative

BIOTRIGO
GENÉTICA

Summary

1. Biotrigo Genética.
2. Wheat in Brazil
   - Southern Brazil is a hotspot for FHB
3. Breeding techniques to increase FHB resistance
4. Limits of DON in Brazil: effects of the new legislation
5. Efforts in the use of marker assisted selection (MAS)
   - Combine the “native” resistance with “exotic” QTLs
6. Future research

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BIOTRIGO GENÉTICA

1. Who is Biotrigo?

- Family own private wheat breeding company
- Partners : Ottoni Rosa Filho and André Rosa
- We proudly work with 65 employees
- 10 year old company - with 29 year of total germplasm development
- We breed:
  - Mainly hard red spring and some facultative (80%)
  - Soft red spring
  - Wheat for silage

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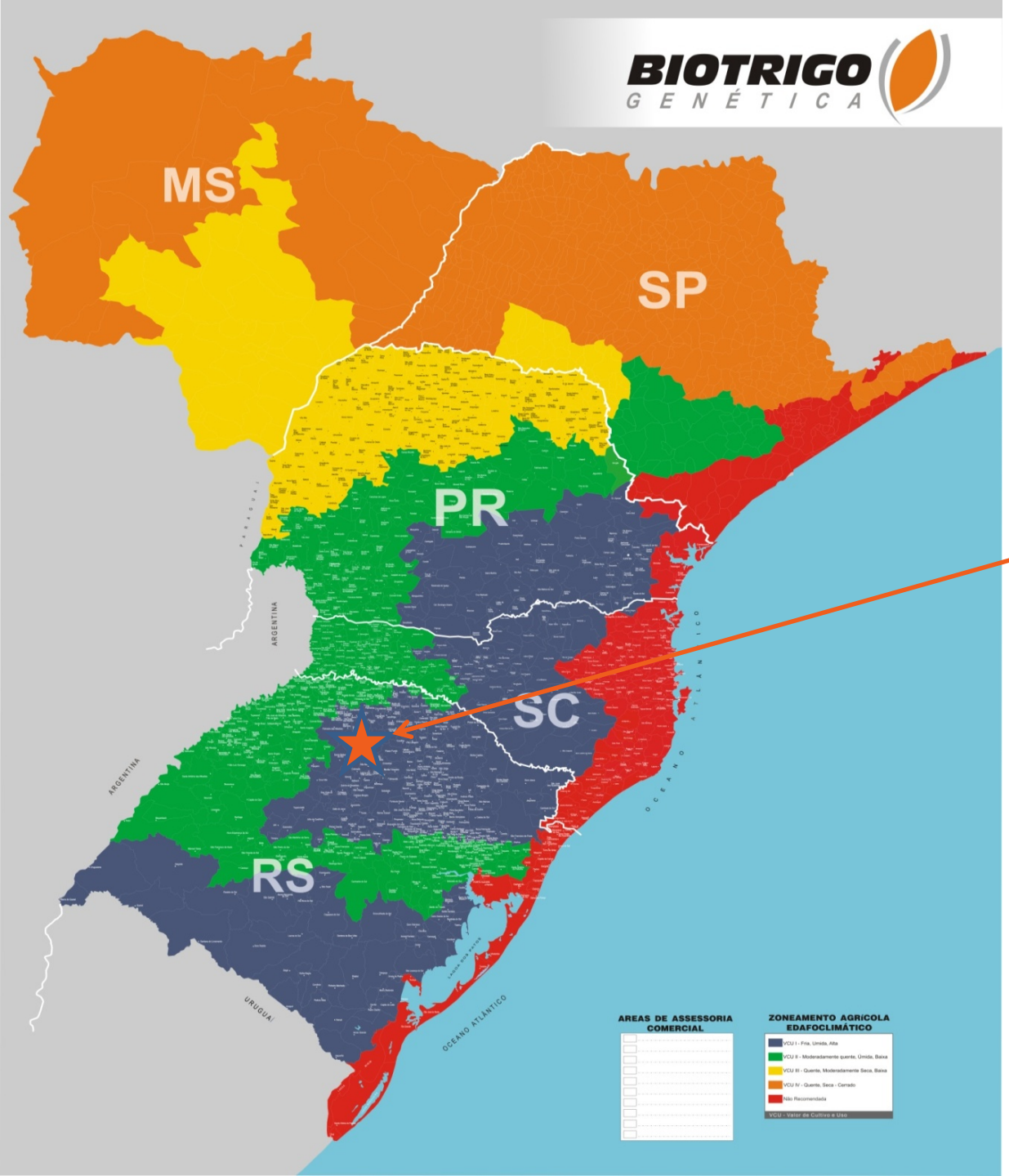
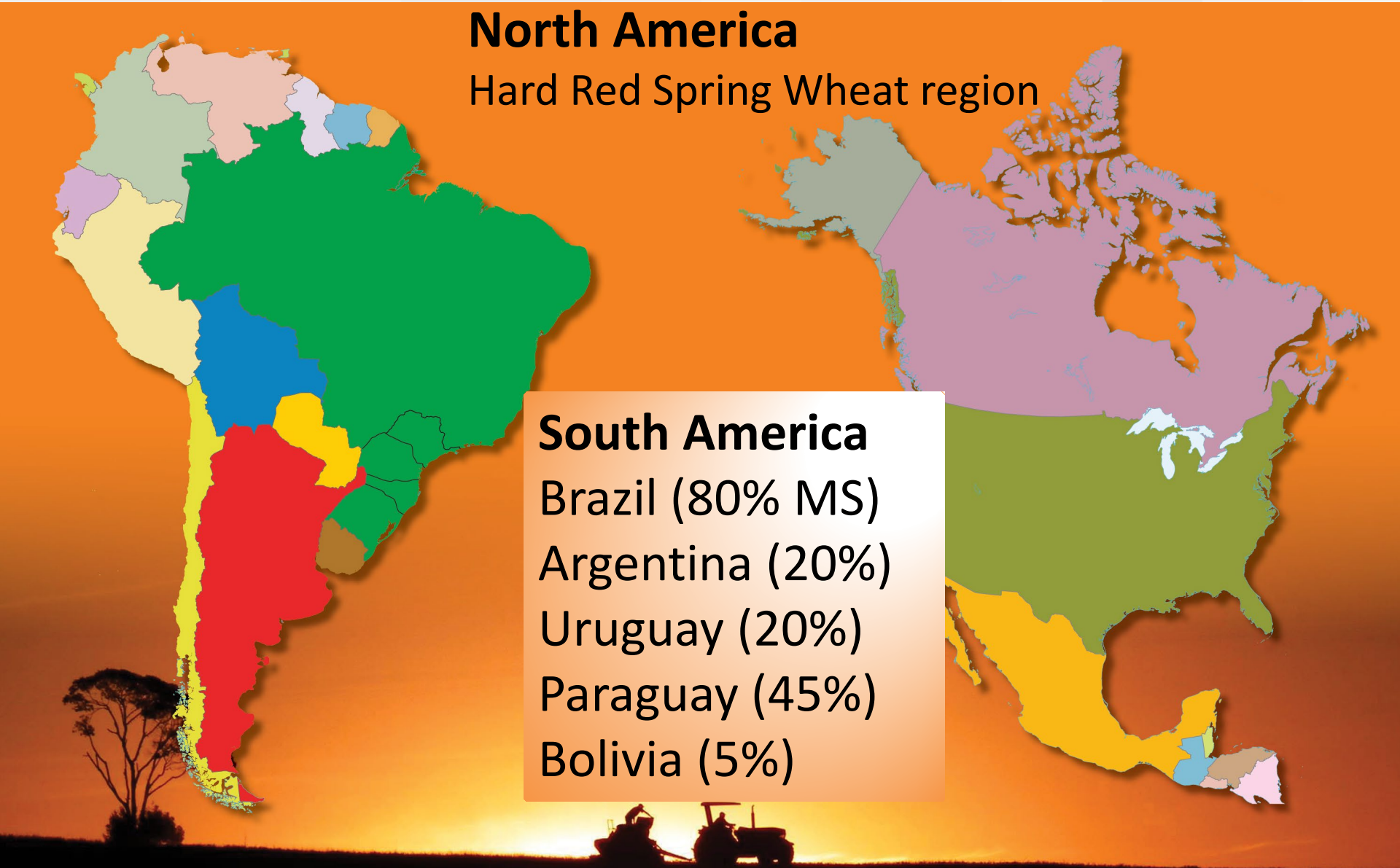


Our location

1. Biotrigo – Headquarter, main building, Passo Fundo, RS

Biotrigo – Headquarter overview

1. Biotrigo - Player



North America

Hard Red Spring Wheat region

South America

Brazil (80% MS)

Argentina (20%)

Uruguay (20%)

Paraguay (45%)

Bolivia (5%)

1. Biotrigo – 3 breeding sites and more than 50 testing

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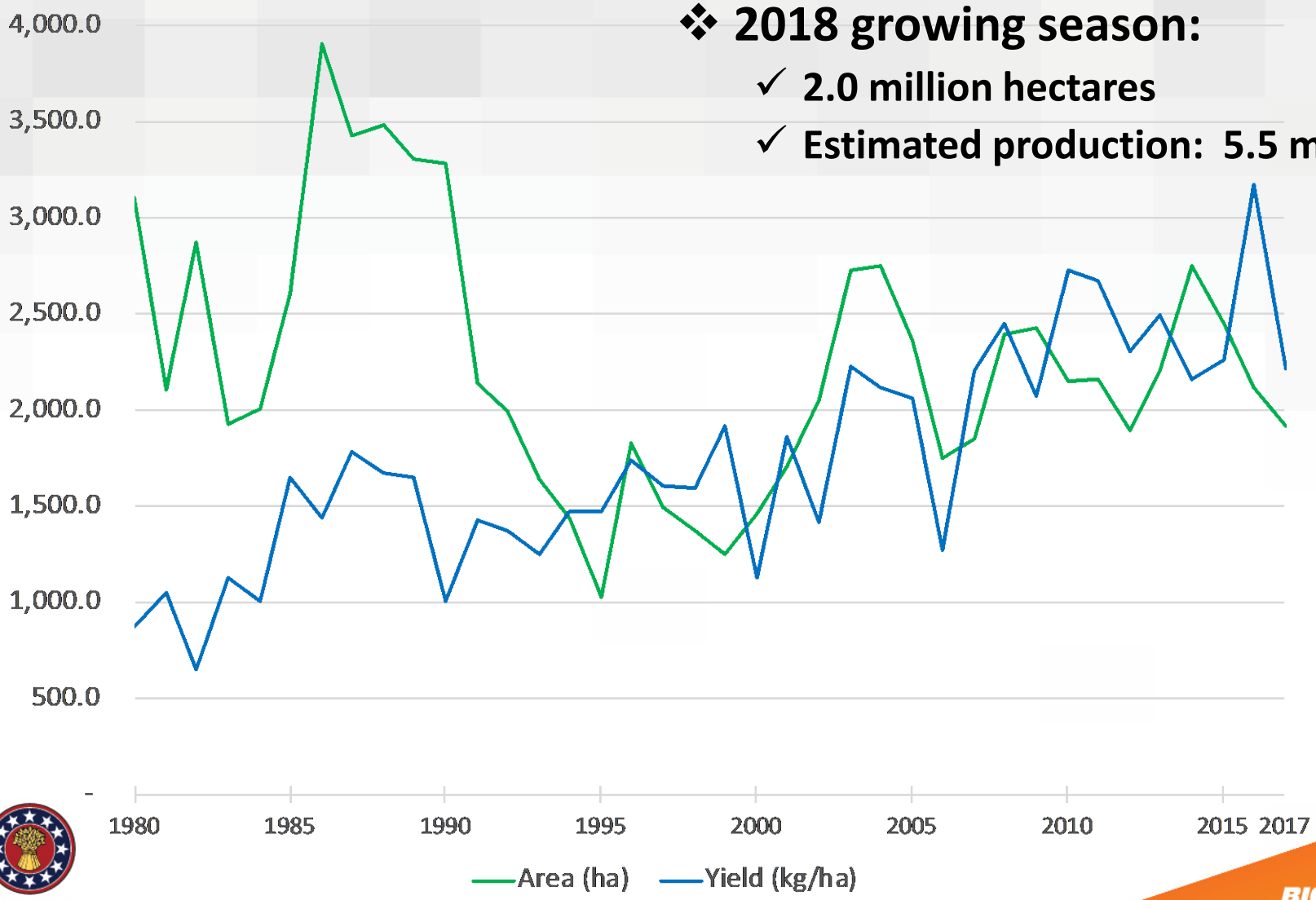
2. Wheat in Brazil



- **2018 growing season:**
  - ✓ **2.0 million hectares**
  - ✓ **Estimated production: 5.5 mi ton**

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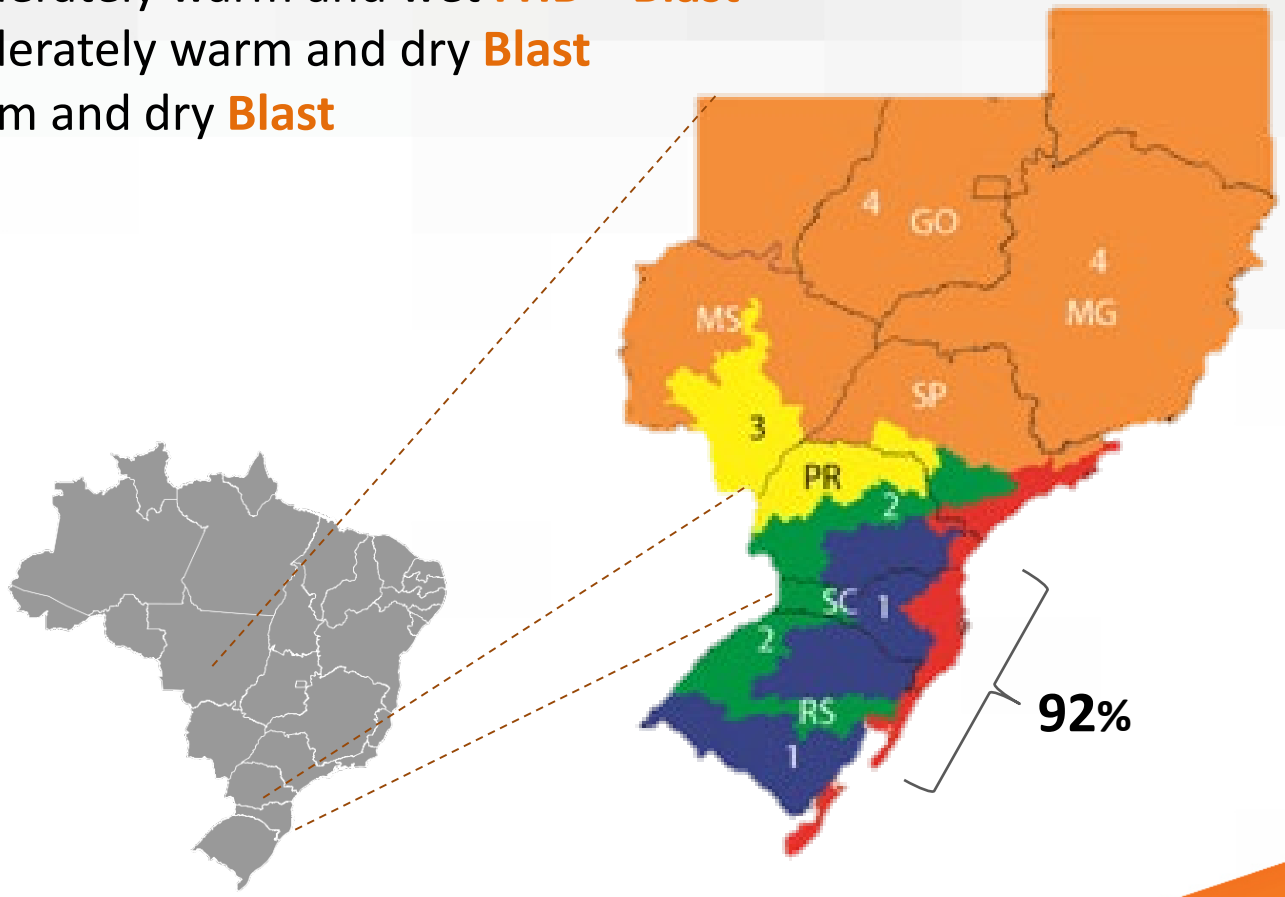
2. Wheat in Brazil

Region 1 Colder and wet **FHB**

Region 2 Moderately warm and wet **FHB + Blast**

Region 3 Moderately warm and dry **Blast**

Region 4 Warm and dry **Blast**



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Brazil: hotspot for wheat diseases

Leaf disease

Tan spot

Powdery mildew

Leaf rust

BLS

SBWMV

BYDV

Spike disease

FHB

Blast

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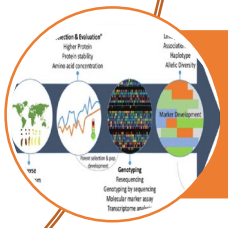
Fusarium head blight (FHB)

Mainly caused by *Fusarium graminearum* (DON/15-ADON genotype)

It is causing economic losses, rising costs and risks

Newer DON-legislation (0.75 ppm flour)



Best strategy to control FHB: **Genetic resistance + fungicide applications**

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Southern Brazil

- Passo Fundo – Rio Grande do Sul
  - **2012 =** wet weather = INTERMEDIATE LOW
  - **2013 =** cold and dry weather = LOW
  - **2014 =** warm and wet = HIGH
  - **2015 =** warm and wet = VERY HIGH (El Niño)
  - **2016 =** cold and dry = VERY LOW
  - **2017 =** warm and dry = LOW
  - **2018 =** cold and wet = VERY HIGH

Level of FHB Infection

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Resistance in Brazil

State of Parana - 2015

Brazil and US

- TBIO Iguaçu = LCS Iguacu
  - Intermediate resistance in Brazil
  - Moderate resistance in US (North Dakota)
  - *"Native" r*esistance based in Frontana (Mostly Type I)

Entry	FHB (ND and MN)
LCS Iguacu (***Fhb1-***)	4
Faller (***Fhb1+***)	4
Glenn	3
SY Soren (***Fhb1+***)	5

https://www.maes.umn.edu/sites/maes.umn.edu/files/2015_spring_wheat_final.pdf

Same level of resistance ?

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Limits of DON in Brazil - 2019

Regulamentation of limit level of Deoxynivalenol (DON) for human consumption.					
			Brazil		
Type of product	Canada	USA	2011	2012-2018	2019
	ppm				
Finished wheat products	2.0	1.0	-	1.75-1.0	0.75

Conclusion: it is necessary to improve the level of resistance!

Field score and DON in "*native*" sources

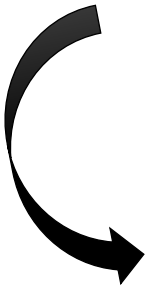
Cultivares	Field Score (1-9)	DON (1-9)
TBIO Sinuelo	4	3
TBIO Sossego	4	3
TBIO Iguaçu	4	4
TBIO Alvorada	4	4
TBIO Sintonia	4	4
TBIO Toruk	5	5
TBIO Tibagi	6	7
TBIO Mestre	5	7
TBIO Bandeirante	7	8
Taurum (Baviacora 's')	9	9
*1 - R and 9 - S		

- ***How should we select/breed to reach level 1 or 2 ?***

Breeding techniques over the years

❖ Conventional breeding techniques

- **Without** the use of molecular markers for FHB;
- Sources: Frontana, Sumai#3, NyuBai, Nabeokabozu, Sha/Catbird, Faller, Carberry, etc ..
- Field notes + Visual scoring of FDK
- Phenotyping **year after year**



- Substantial, but **NOT** sufficient level of resistance;

MAS for FHB resistance

❖ **Objective**: Combine the resistance

- Maintain the "*native*" resistance:

- *..... Frontana (+ 17 QTL's, Ágnes et al., 2014)*

- Introduction of the major Fhb genes/QTL's present in "*exotic*" sources

..... Sumai#3 and others (Fhb1, ..., Fhb5 and many Qtl's)

Germplasm development based in Sumai#3

❖ **Phase 1 – started in 2011**

- TBIO Alvorada – 100% Brazilian lines on the pedigree
- Cross 1: **Alvorada/Sumai#3//Alvorada**
- MAS in BC1 and F2 – Only *Fhb1* (AA and Aa)
- Phenotyping in the field

DON - ppm

	Genotype	Average 3 loc. 2014
	Sumai#3	1,1
Cross: ALV/Sumai#3//ALV (*selected lines*)	Fhb1 + Fhb5 + QTL'7A + Q	1,3
	Fhb1 + QTL'7A + QTL'	1,7
	Fhb1 + Fhb5 + Q	2,1
	Fhb1 + QTL'	2,2
	QTL'5A	2,6
	Sin QTL'3A	3,2
		3,4
	Si QTL'5A	3,5
	Alvo a = QTL'5A	3,75
	Toruk = QTL'5A	4
	Mestre = QTL'5A	4,4

Good resistance and poor agronomics

DON vs FHB field infection

Cultivares	DON (1-9)	Field Score (1-9)
TBIO Sinuelo	3	4
TBIO Sossego	3	4
TBIO Iguaçu	4	4
TBIO Alvorada	4	4
TBIO Sintonia	4	4
TBIO Toruk	5	5
TBIO Tibagi	7	6
TBIO Mestre	7	5
TBIO Bandeirante	8	7
Taurum	9	9
* 1 - R and 9 - S		

Combining "*native*" and "*exotic*"

❖ **Phase 2 – started in 2013**

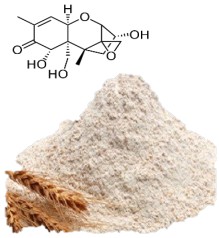
- Introduction of Sumai#3 genes into elite line;
- TBIO Toruk: Top yielder – became #1 cultivar soon
- Cross 2: Toruk*2/3/Alvorada/Sumai#3//Alvorada
- MAS in BC1 and F2 – Only *Fhb1* (AA and Aa)
- Phenotyping in field and greenhouse (type II)

Phenotyping – Field selection

Phenotyping - FHB nursery

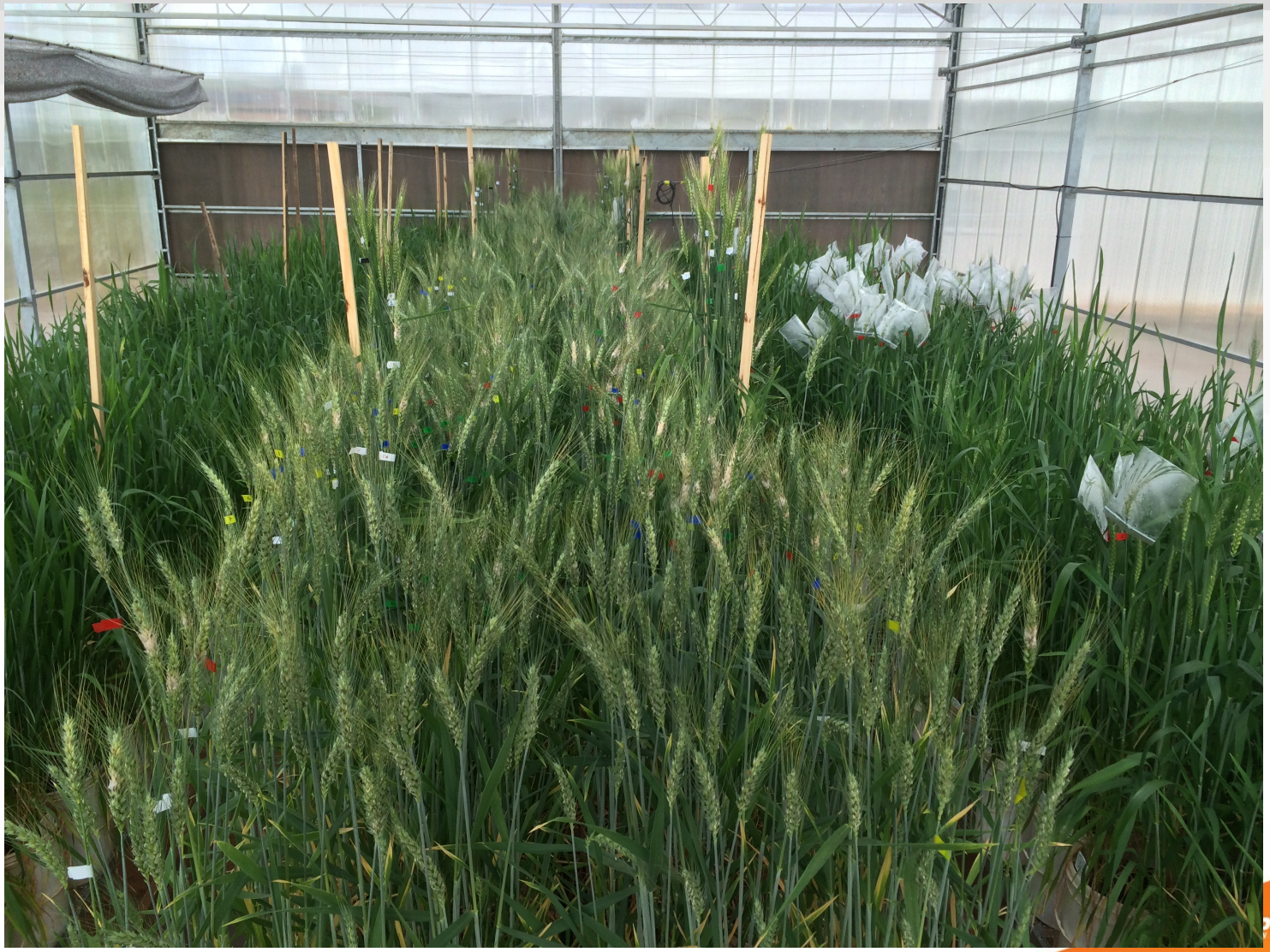
PSS (type I and II)

FDK (type IV)

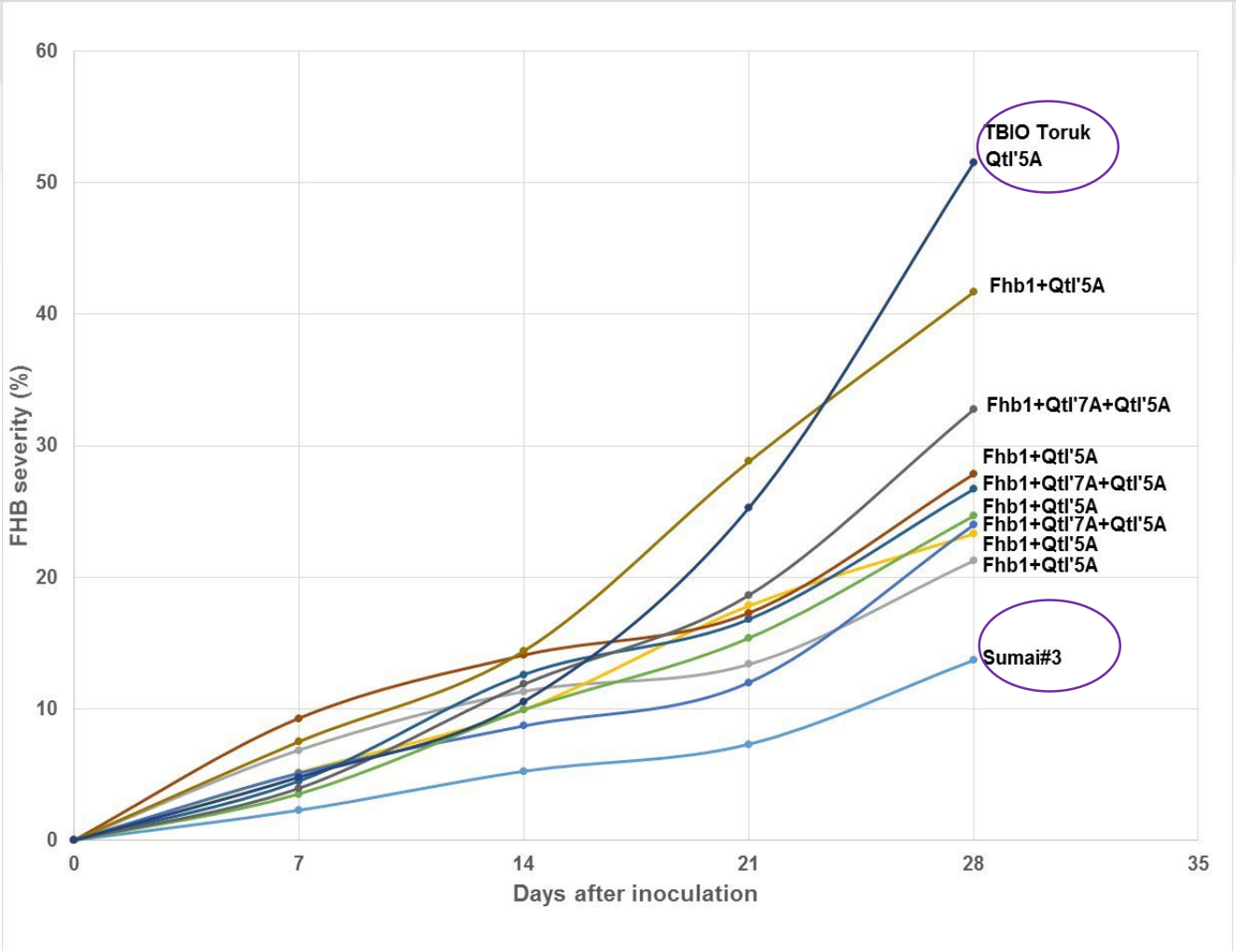


DON (type III)

Phenotyping – Type II resistance



Phenotyping – Type II resistance



Results – After Phase #2

- Improved agronomics considerably

- Type II improved from Toruk

- Type I kept at insuficiente levels

Conclusion – without enough type I, type II is of little use for the region. There are too many infection points!!!!!

Combining "*native*" and "*exotic*"

❖ **Phase #3 – started in 2015**

- Objective: spreading Sumai#3 genes into the germplasm
- 2018 provided good condition to select in the field
- More than 30 agronomically acceptable lines were observed as promising for Fhb.
- Did we manage to lower DON?
- **Will those make a comercial release?**

While breeding does not solve all the problems, we will indicate:

- Pick best cultivars when possible
- Use best fungicides – two or three application starting at heading
- Pay much attention to spraying technology
- Use forcast sistem (basically -protect if rain is coming) - SISALERT
- Use post harvest cleanears at elevators and mills

6. Future research – Phase # 4, 5 , ∞

- Evaluate our sources (phenotype and haplotype) and keep introducing new sources
- Plan what is the best f
- Start effort to ection (collaboration)
- Increase efforts on mapping and validating QTL (collaboration)
- **Keep working to able to effectively release a cultivar with improved resistance!**

Cultivar released, chosen by the farmers and accepted by mills is what "pays the bills"!

Many thanks to:

FHB Forum 2018

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U.S. Wheat & Barley Scab Initiative

Igor Valério, Ph.D.

Our whole Team

Thank you for your attention